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September 28, 1999

BOX PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231

Re: Application of Tsugio OKAMOTO
"ADDRESS CONVERTER FOR GATEWAYS INTERCONNECTING NETWORKS OF DIFFERENT ADDRESS FORMATS"
Our Ref. Q056006

Dear Sir:

Attached hereto is the application identified above including 11 sheets of the specification and claims, and 5 sheets of informal drawings. The executed Declaration and Power of Attorney and Assignment will be submitted at a later date.

The Government filing fee is calculated as follows:

Total claims	10	- 20	=	x	$18.00	=
Independent claims	2	- 3	=	x	$78.00	= $.00
Base Fee						$760.00
TOTAL FILING FEE						**$760.00**

A check for the statutory filing fee of $760.00 is attached. You are also directed and authorized to charge or credit any difference or overpayment to Deposit Account No. 19-4880. The Commissioner is hereby authorized to charge any fees under 37 C.F.R. §§ 1.16 and 1.17 and any petitions for extension of time under 37 C.F.R. § 1.136 which may be required during the entire pendency of the application to Deposit Account No. 19-4880. A duplicate copy of this transmittal letter is attached.

Priority is claimed from September 28, 1998 based on Japanese Application No. 274034/98. The priority document will be filed at a later date.

Respectfully submitted,
SUGHRUE, MION, ZINN,
MACPEAK & SEAS, PLLC
Attorneys for Applicant

By: _____
Howard L. Bernstein
Reg. No. 25,665

TITLE OF THE INVENTION

"ADDRESS CONVERTER FOR GATEWAYS INTERCONNECTING NETWORKS OF DIFFERENT ADDRESS FORMATS"

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to address conversion and more specifically to conversion of address data contained in a packet when the packet travels between networks of different address formats.

Description of the Related Art

Address conversion is necessary for a gateway when routing a packet from a first network to a second network if the address formats of the networks are different from each other. For example, in an internetwork environment, local private networks are connected to remote private networks via a global network. In such configurations, addresses of the private networks are organized independently of those assigned by the global network in order to facilitate address management of the private networks.

An address converter disclosed in Japanese Laid-Open Patent Specification 09-233112 uses a database that maps addresses of a first network to corresponding addresses of a second network. When the address converter receives a packet from the first network, it makes a search through the database for the corresponding address data of the second network that is mapped to the address data contained in the packet. However, if the amount of data contained in the database increases with an increasing number of users, the time taken to search through the database becomes substantial. Hence, there is a significant amount of latency in the transmission of packets across different networks.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide

a method of packet transmission and an address converter for reducing the latency of packets travelling across first and second networks of different address formats.

The stated object is achieved by transmitting second address data conforming to the second network with first address data that conforms to the first network.

According to a first aspect of the present invention, there is provided a method of transmitting packets between first and second networks of different address formats, comprising the steps of (a) receiving, from a first network, a packet containing first address data conforming to the first network and second address data conforming to a second network, the first address data being contained in a packet header of the packet and the second address data being contained in an auxiliary header of the packet, (b) rewriting the first address data with the second address data, and (c) transmitting the packet to the second network.

According to a second aspect of the present invention, there is provided an address converter for use in a gateway connected between first and second networks of different address formats, comprising receive means for receiving, from the first network, a packet containing first address data formulated according to the first network and second address data formulated according to the second network, the first address data being contained in a packet header of the packet and the second address data being contained in an auxiliary header of the packet. Control means is provided for rewriting the first address data of the packet with the second address data of the packet. Transmit means transmits the packet to the second network.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described in further detail with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram of a communication system in which the gateway of the present invention is shown interconnecting networks of different address formats;

Fig. 2 shows the data format of a packet used in the present invention;

Fig. 3 is a flowchart of the operation of the controller of Fig. 1 when performing an address conversion on an incoming packet according to a first embodiment of the present invention;

Figs. 4A and 4B are illustrations of the register during address conversion according to the first embodiment;

Fig. 5 is a flowchart of the operation of the controller when performing an address conversion on an incoming packet according to a second embodiment of the present invention; and

Figs. 6A and 6B are illustrations of the register during address conversion according to the second embodiment.

DETAILED DESCRIPTION

Fig. 1 illustrates a gateway 10 of the present invention for interconnecting networks 11 and 12 via communication links 13 and 14. The address format of each network is different from the address format of the other, and for this reason, the gateway 10 includes a pair of address converters 21 and 22 of identical construction, each for a particular direction of transmission. Specifically, the address converter 21 provides address conversion on signals received from the network 11 via an interface unit 20 to the network 12 via an interface unit 23, the address converter 22 providing address conversion on signals received from the network 12 via interface unit 23 to the network 11 via interface unit 20.

As shown in detail, the address converter 22 includes an input buffer 30 for buffering incoming packets from the link 14, and a register 31 for storing a packet from the input buffer 30 on a one-at-a-time basis. A controller 32 is provided for making a search through the register 30 for target address data when a

packet is stored. Controller 32 performs conversion of the packet's address data using the target address data and formulates an outgoing packet in a manner as will be described in detail later, and forwards the outgoing packet to an output buffer 34 where the packet is buffered and transmitted to the link 13.

An address conversion table 33 is also connected to the controller 32 to be used when the target address data is not found in the received packet. Address conversion table 33 maps the address data of a network to corresponding address data of another network.

As shown in Fig. 2, the packet of the present invention is divided into a packet header (such as Ipv6 header), an auxiliary header following the packet header and a payload field. The packet header consists of a destination address (DA_1) field 41, a source address (SA_1) 42 and a remainder field 43 for mapping other header information. The original destination and source addresses DA_1 and SA_1 are conforming to the format of the source network.

According to the present invention, the auxiliary header includes a target address field and an auxiliary information field. The target address field is divided into subfields 44, 45 and 46 for respectively mapping a field indicator FI_1 for specifying the auxiliary header, a target destination address (DA_2) and a target source address (SA_2). The target destination and source addresses DA_2 and SA_2 are conforming to the format of the destination network. The auxiliary information field is divided into subfields 47 and 48 for respectively mapping a field indicator FI_2, which specifies the auxiliary information field 48, and auxiliary information. The auxiliary information field 48 is followed by a payload field 49 in which payload bits are placed.

According to a first embodiment of the present invention, the operation of the controller 32 of each address converter

proceeds according to the flowchart of Fig. 3.

When an incoming packet is received in the input buffer 30 and then transferred to the register 31 (step 301), the contents of the packet are stored in storage locations 51 to 59 of the register as shown in Fig. 4A corresponding to fields 41 to 49 of the packet.

The controller 32 proceeds to step 302 to make a search through the register 31 to determine if there is an auxiliary header to determine (step 303). If there is none, the decision at step 303 is negative and the controller proceeds to step 306 to perform an address conversion on the incoming packet using the conversion table 33 and forwards the address-converted packet to the output buffer 34 (step 308) and proceeds to the end of the routine.

If the decision at step 303 is affirmative, the controller proceeds to step 304 to make a search through the auxiliary header to determine if it contains a target address field (step 305). If there is none, the controller proceeds to step 306.

If target address data is contained in the auxiliary header, the decision at step 305 is affirmative and the controller proceeds to step 307 to discard DA_1, SA_1, FI_1 and move DA_2, SA_2 to storage locations 51, 52 of the register 30, and move FI_2, auxiliary information and payload data from locations 57 to 59 to the left so that FI_2 immediately follows the header information stored in location 53. In this way, an outgoing packet is formulated in the register 31 as shown in Fig. 4B.

The controller then forwards the outgoing packet to the output buffer 34 for transmission. Because the storage locations 55, 56 and 57 are eliminated, the whole length of the outgoing packet is advantageously shorter than the incoming packet in terms of bandwidth occupied during transmission.

Therefore, the destination and source addresses of the source network contained in the incoming packet are converted to the addresses of the destination network.

Since time-consuming table search is not required for packets if they contain the address data of their destination network, they experience a minimum latency when they travel from one network to another. Further, the cost of the gateway is reduced due to the elimination of the need to provide costly high speed address conversion.

In the previous embodiment, the target addresses cannot be reconverted to the original addresses, and hence the original addresses can no longer be used. However, there may be instances where an intermediate network is interposed between the source and destination networks, and the source and destination networks use the same address format while the intermediate network uses a different address format. In such applications, the original addresses are converted to the target addresses in a first gateway at the boundary between the source and intermediate networks and the target addresses are reconverted to the original addresses in a second gateway at the boundary between the intermediate and destination networks.

This is implemented by transposing the original address data and the target address data between different storage location of the register 31 according to a flowchart shown in Fig. 5, in which steps corresponding to those in Fig. 3 are marked with the same numerals as those in Fig. 3 and the description thereof is omitted for simplicity.

Fig. 5 differs from Fig. 3 in that if the decision at step 305 is affirmative, the routine proceeds to step 501 to transpose DA_1 and SA_1 with DA_2 and SA_2 between storage locations 51, 52 and storage locations 55, 56 of the register 31, as shown in Fig. 6A, so that an outgoing packet is formulated in the register as shown in Fig. 6B.

It will be seen that when a packet is received in a first gateway from a source network, the address data DA_1 and SA_1 of

the source network are converted to the address data DA_2 and SA_2 of an intermediate network and transmitted through the intermediate network to a second gateway. In the second gateway, the address data DA_2 and SA_2 of the intermediate network are reconverted to the address data DA_1 and SA_1 of a destination network and transmitted through the destination network where the packet is routed to a destination terminal.

What is claimed is:

1. A method of transmitting packets between first and second networks of different address formats, comprising the steps of:

a) receiving, from a first network, a packet containing first address data conforming to said first network and second address data conforming to a second network, said first address data being contained in a packet header of the packet and said second address data being contained in an auxiliary header of the packet;

b) rewriting said first address data with said second address data; and

c) transmitting the packet to said second network.

2. The method of claim 1, wherein said auxiliary header further contains auxiliary information.

3. The method of claim 2, wherein the step (b) further comprises eliminating from said packet a field in which said second address data is contained.

4. The method of claim 1, wherein the step (b) further comprises writing said first address data into said auxiliary header.

5. The method of claim 1, wherein the step (b) comprises the steps of:

making a search through a received packet;

examining a database if said auxiliary header is not contained in the received packet and detecting address data

mapped to said first address data; and

converting the first address data with the detected address data.

6. An address converter for use in a gateway connected between first and second networks of different address formats, comprising:

receive means for receiving, from said first network, a packet containing first address data conforming to said first network and second address data conforming to said second network, said first address data being contained in a packet header of the packet and said second address data being contained in an auxiliary header of the packet;

control means for rewriting said first address data with said second address data; and

transmit means for transmitting the packet to said second network.

7. The address converter of claim 6, wherein said auxiliary header further contains auxiliary information.

8. The address converter of claim 7, wherein the control means is arranged to eliminate, from said packet, a field in which said second address data is contained.

9. The address converter of claim 6, wherein said control means is arranged to write said first address data into said auxiliary header.

10. The address converter of claim 6, wherein said control means comprises a database and is arranged to:

make a search through a received packet;

examine said database if said auxiliary header is not contained in the received packet and detecting address data mapped to said first address data; and

convert the first address data with the detected address data.

ABSTRACT OF THE DISCLOSURE

In a gateway, a packet received from a first network contains first address data conforming to the first network in the packet header and second address data conforming to a second network in an auxiliary header. The first address data of the packet is then rewritten with the second address data of the packet and transmitted from the gateway to the second network.

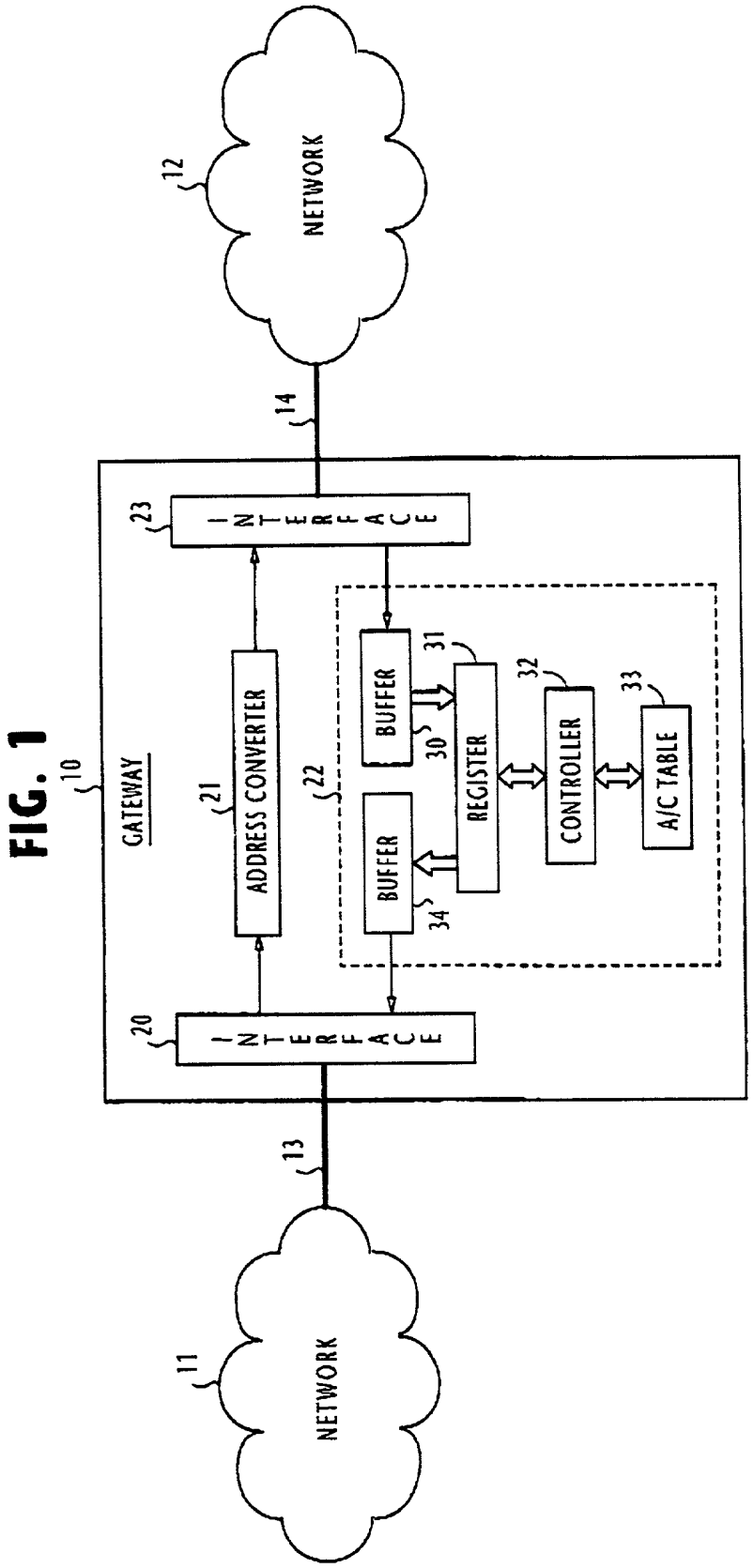

NETWORK
12
14
GATEWAY
10
INTERFACE
23
ADDRESS CONVERTER
21
22
BUFFER
31
30
REGISTER
32
CONTROLLER
33
A/C TABLE
BUFFER
34
INTERFACE
20
13
NETWORK
11

FIG. 1

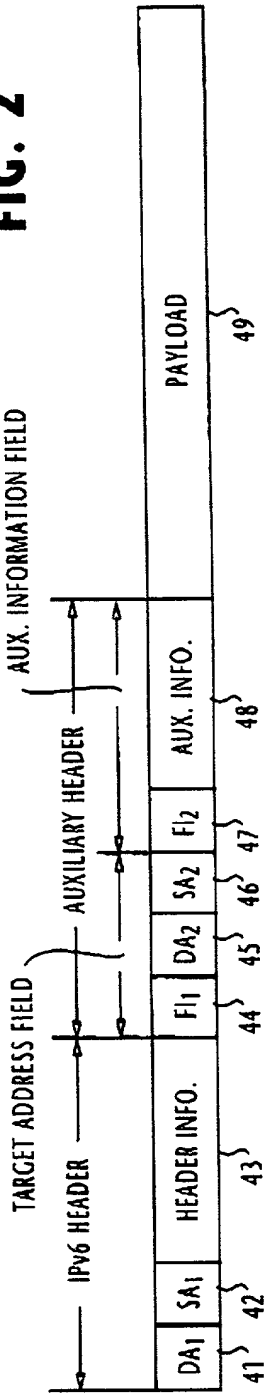
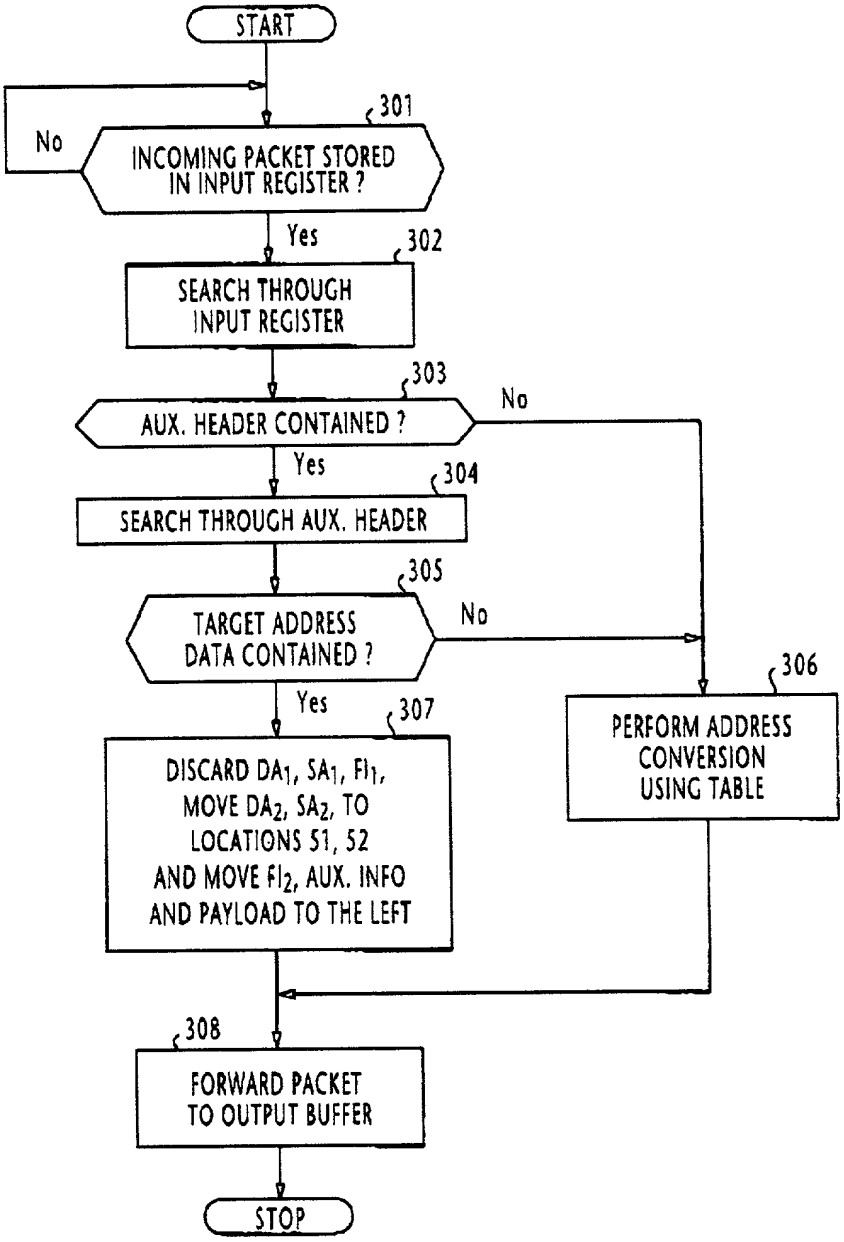

AUX. INFORMATION FIELD
PAYLOAD
49
AUX. INFO.
48
FI2
47
SA2
46
DA2
45
FI1
44
HEADER INFO.
43
SA1
42
DA1
41
AUXILIARY HEADER
TARGET ADDRESS FIELD
IPv6 HEADER

FIG. 2

FIG. 3


START
301
No
INCOMING PACKET STORED IN INPUT REGISTER ?
Yes
302
SEARCH THROUGH INPUT REGISTER
303
AUX. HEADER CONTAINED ?
No
Yes
304
SEARCH THROUGH AUX. HEADER
305
TARGET ADDRESS DATA CONTAINED ?
No
Yes
306
PERFORM ADDRESS CONVERSION USING TABLE
307
DISCARD DA1, SA1, FI1, MOVE DA2, SA2, TO LOCATIONS 51, 52 AND MOVE FI2, AUX. INFO AND PAYLOAD TO THE LEFT
308
FORWARD PACKET TO OUTPUT BUFFER
STOP

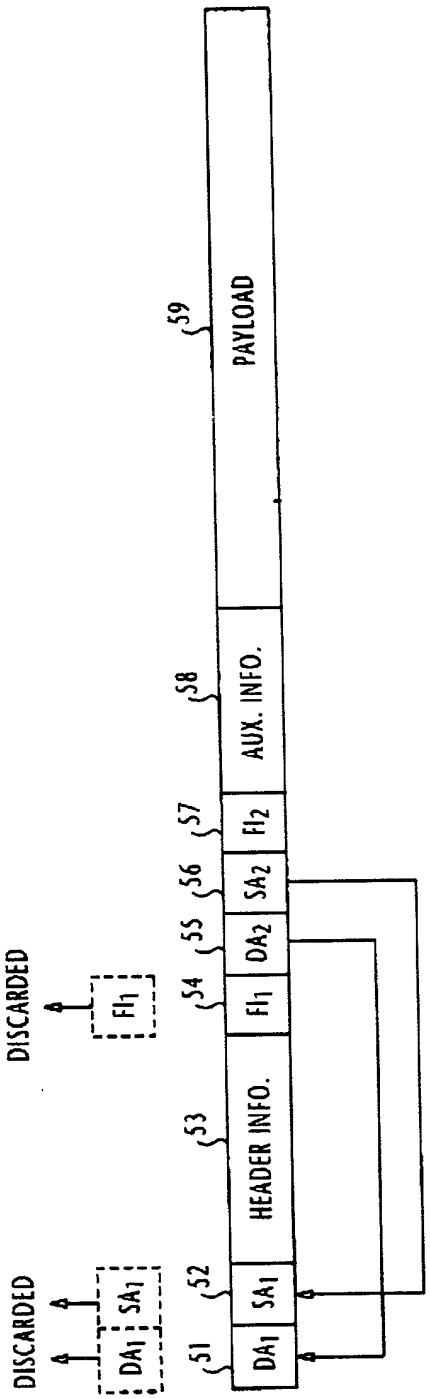

DISCARDED
DISCARDED
DA1
SA1
FI1
DA1
SA1
HEADER INFO.
FI1
DA2
SA2
FI2
AUX. INFO.
PAYLOAD
51
52
53
54
55
56
57
58
59

FIG. 4A

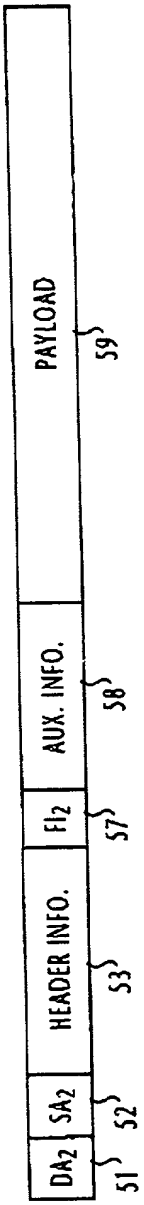
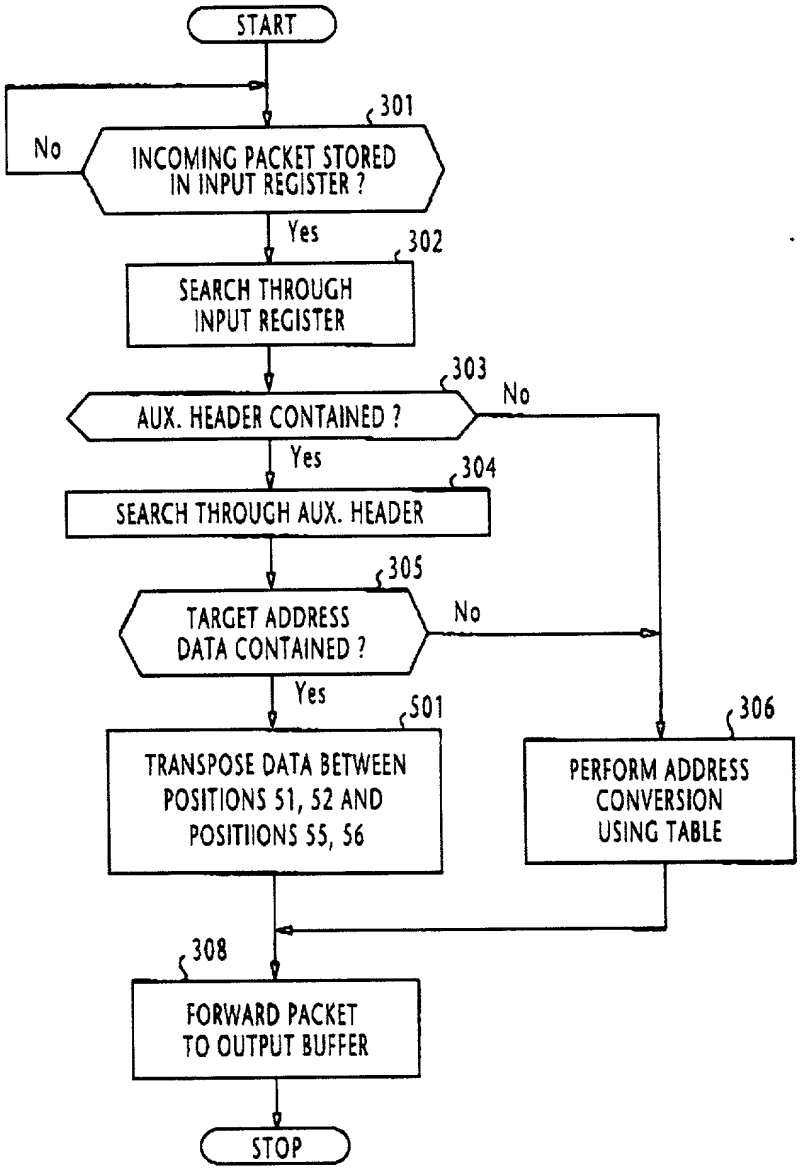

DA2
SA2
HEADER INFO.
FI2
AUX. INFO.
PAYLOAD
51
52
53
57
58
59

FIG. 4B

FIG. 5


START
301
No
INCOMING PACKET STORED IN INPUT REGISTER ?
Yes
302
SEARCH THROUGH INPUT REGISTER
303
No
AUX. HEADER CONTAINED ?
Yes
304
SEARCH THROUGH AUX. HEADER
305
TARGET ADDRESS DATA CONTAINED ?
No
Yes
501
TRANSPOSE DATA BETWEEN POSITIONS 51, 52 AND POSITIIONS 55, 56
306
PERFORM ADDRESS CONVERSION USING TABLE
308
FORWARD PACKET TO OUTPUT BUFFER
STOP

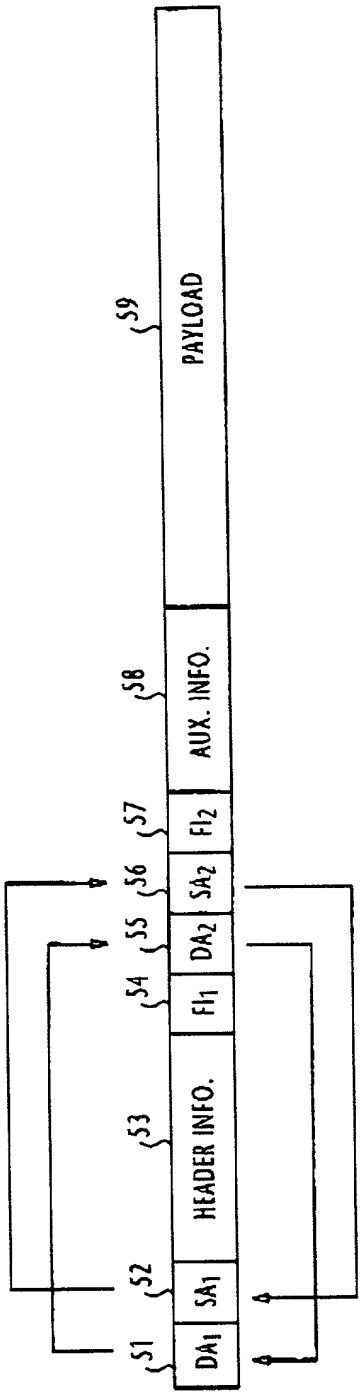

DA1
SA1
HEADER INFO.
FI1
DA2
SA2
FI2
AUX. INFO.
PAYLOAD
S1
S2
S3
S4
S5
S6
S7
S8
S9

FIG. 6A

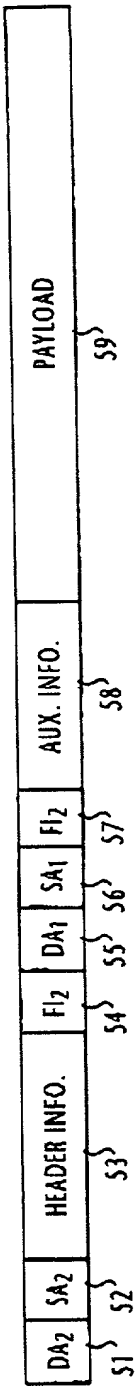

DA2
SA2
HEADER INFO.
FI2
DA1
SA1
FI2
AUX. INFO.
PAYLOAD
S1
S2
S3
S4
S5
S6
S7
S8
S9

FIG. 6B